6.   FLOW DIAGRAMS

The RWEQ program is written in "C" language.   The WEQ coding was sent by NRCS to Manhattan and then to Dr. Saleh in Big Spring.   Dr. Saleh modified the coding to include new science (technology), upgraded the interface (Vermont Views 4.05), included extended memory, deleted nonessential portions, and incorporated new factors (*e.g.* input screen, output, graphics, etc.).

Coding has been reviewed by Chuck Meyer, USDA and Bob Pickle, Vermont Views software consultant. Suggestions from these reviewers have been incorporated in RWEQ Version 97. To facilitate maintenance of the code, comments and documentation are being added.

Two sets of flow diagrams are presented. Traditional computer flow diagrams by Dr. Saleh are in Section 6.1. If these illustrate and answer all of your questions on RWEQ programs, do not read Section 6.2.

Generalized flow diagrams are given in Section 6.2. They are intended to illustrate the sequences in which the input data are used to compute changes in surface conditions and soil erosion.

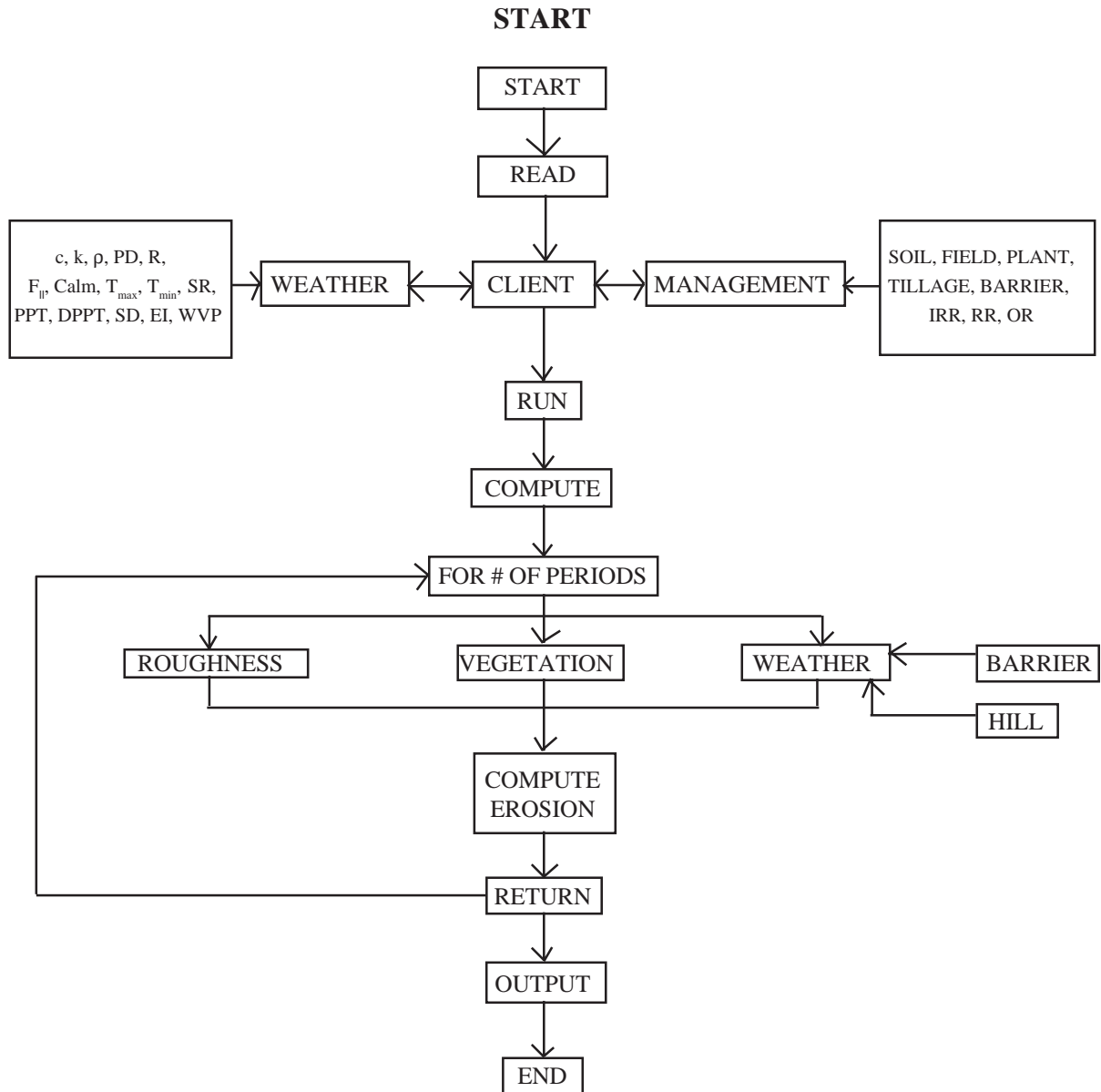## 6.1   DR. SALEH'S TRADITIONAL COMPUTER FLOW DIAGRAMS

6.1.1 Start

6.1.2 Roughness

6.1.3 Vegetation

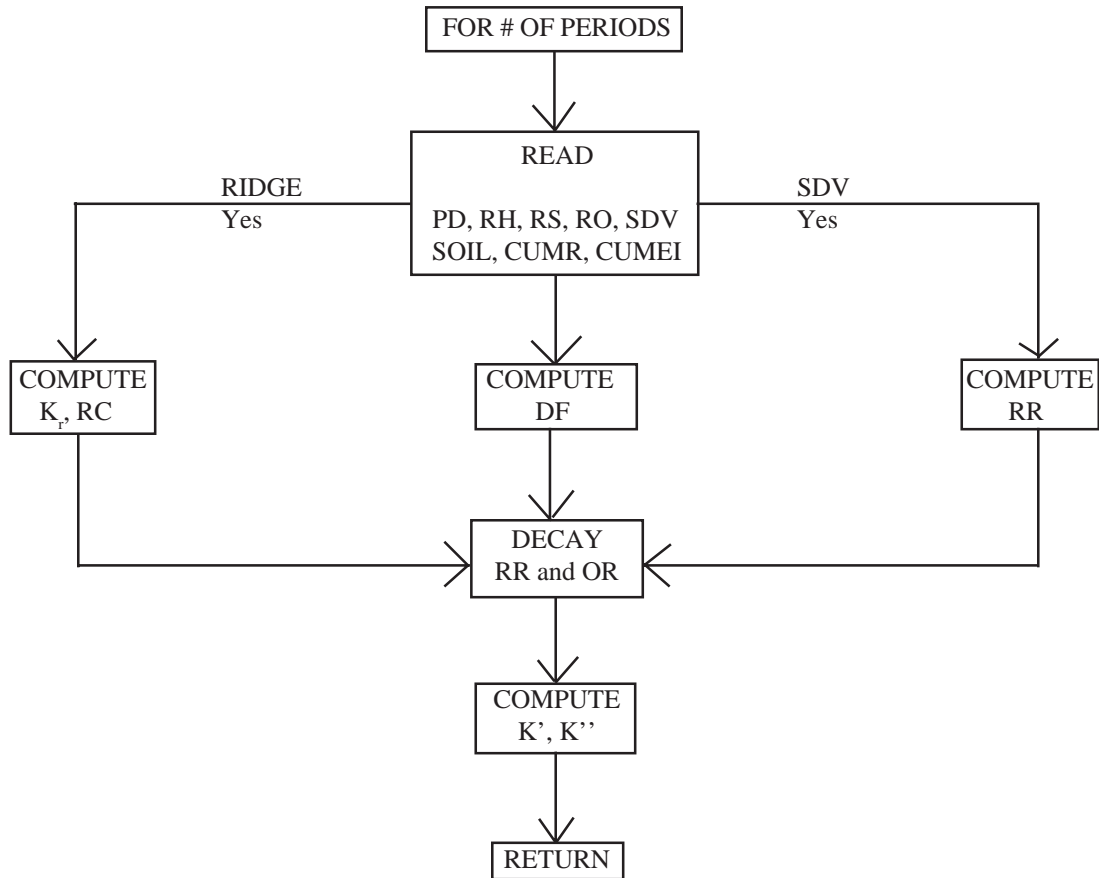### 6.1.4 Weather

6.1.5 Erosion

Flow Diagram 6.1.1

START

START

↓

READ

↓

| c, k, ρ, PD, R,
 $F_{\parallel}$, Calm, T_{max}, T_{min}, SR,
 PPT, DPPT, SD, EI, WVP | → | WEATHER | ← | CLIENT | ↔ | MANAGEMENT | ← | SOIL, FIELD, PLANT,
 TILLAGE, BARRIER,
 IRR, RR, OR |

↓

RUN

↓

COMPUTE

↓

FOR # OF PERIODS

ROUGHNESS   VEGETATION   WEATHER ← BARRIER

WEATHER ← HILL

↓

COMPUTE
EROSION

↓

RETURN

↓

OUTPUT

↓

END

c	= Weibull scale parameter	SD	= probability of snow cover
k	= Weibull shape parameter	EI	= storm erosivity index
ρ	= air density	WVP	= wind velocity probability value
PD	= prevailing wind direction	SOIL	= % sand, % silt, % clay, % OM, % $CaCO_3$
R	= preponderance	FIELD	= size, shape, orientation, and length
$F_{\parallel}$	= positive parallel ratio	PLANT	= residue and growing crop properties
CALM	= no wind	TILLAGE	= tillage operations
T_{max}	= average maximum temperature	BARRIER	= height, spacing, porosity, and orientation
T_{min}	= average minimum temperature	IRR	= amount, rate, and number of irrigations
SR	= solar radiation	RR	= random roughness (standard dev. of aggregates)
PPT	= precipitation	OR	= oriented roughness (ridge height, ridge spacing, direction)
DPPT	= number of rain days	HILL	= height and slope gradient

Flow Diagram 6.1.2

ROUGHNESS

```
                        ┌─────────────────┐
                        │ FOR # OF PERIODS │
                        └─────────────────┘
                                 │
                                 ▼
           RIDGE          ┌──────────────┐          SDV
           Yes            │    READ      │          Yes
        ┌────────────────│ PD, RH, RS, RO, SDV │────────────────┐
        │                │ SOIL, CUMR, CUMEI │                  │
        │                └──────────────┘                      │
        ▼                      │                                ▼
┌──────────────┐               ▼                        ┌──────────────┐
│   COMPUTE    │        ┌──────────────┐                │   COMPUTE    │
│   Kr, RC     │        │   COMPUTE    │                │     RR       │
└──────────────┘        │     DF       │                └──────────────┘
        │               └──────────────┘                        │
        │                      │                                │
        │                      ▼                                │
        │               ┌──────────────┐                        │
        └──────────────▶│    DECAY     │◀───────────────────────┘
                        │   RR and OR  │
                        └──────────────┘
                               │
                               ▼
                        ┌──────────────┐
                        │   COMPUTE    │
                        │   K', K''    │
                        └──────────────┘
                               │
                               ▼
                        ┌──────────────┐
                        │    RETURN    │
                        └──────────────┘
```

PD	= wind direction	K_r	= ridge roughness coefficient
RH	= ridge height	RC	= rotational coefficient
RS	= ridge spacing	DF	= decay factor
RO	= ridge orientation	RR	= random roughness
SDV	= standard deviation of random roughness	OR	= oriented roughness
SOIL	= % sand, % silt, % clay, % OM, % $CaCO_3$	K'	= soil roughness coefficient perpendicular to wind
CUMR	= cumulated rainfall and irrigation	K''	= soil roughness coefficient parallel to wind
CUMEI	= cumulated storm erosivity index		

Flow Diagram 6.1.3

VEGETATION

FOR # OF PERIODS

READ
YIELD, STEMN, RES DEC, pgca, pgcb,
T_{max}, T_{min}, PPT, IRR, BC, FC, PRC

CANOPY
YES

COMPUTE
FLAT & STAND RES

STEM
YES

COMPUTE
FLAT & STAND RES

COMPUTE
SILHOUETTE

COMPUTE
% CANOPY COVER

COMPUTE
% RESIDUE COVER

ADD
% ROCK COVER

COMPUTE
SLR_s

COMPUTE
SLR_f

COMPUTE
SLR_c

RETURN
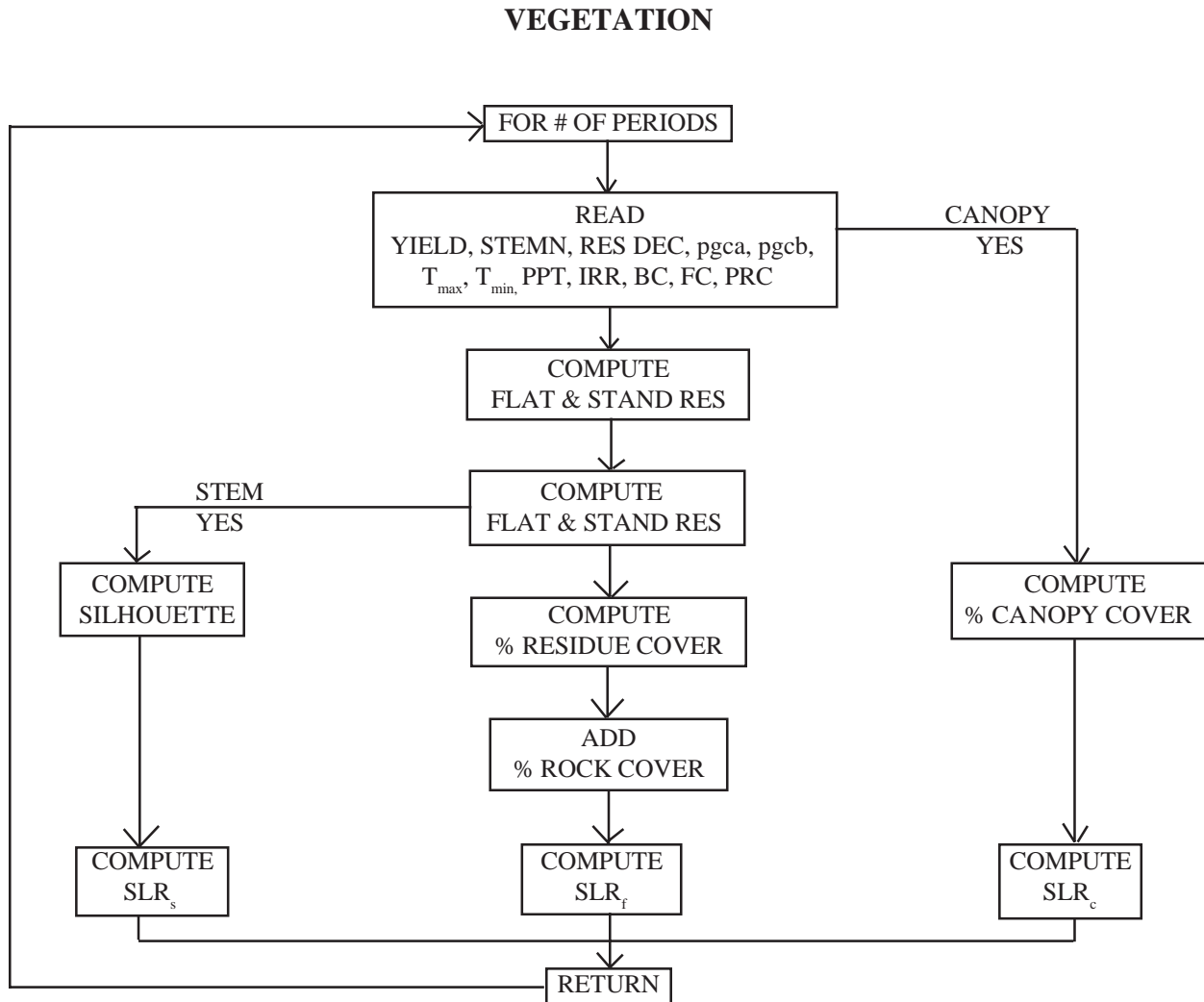
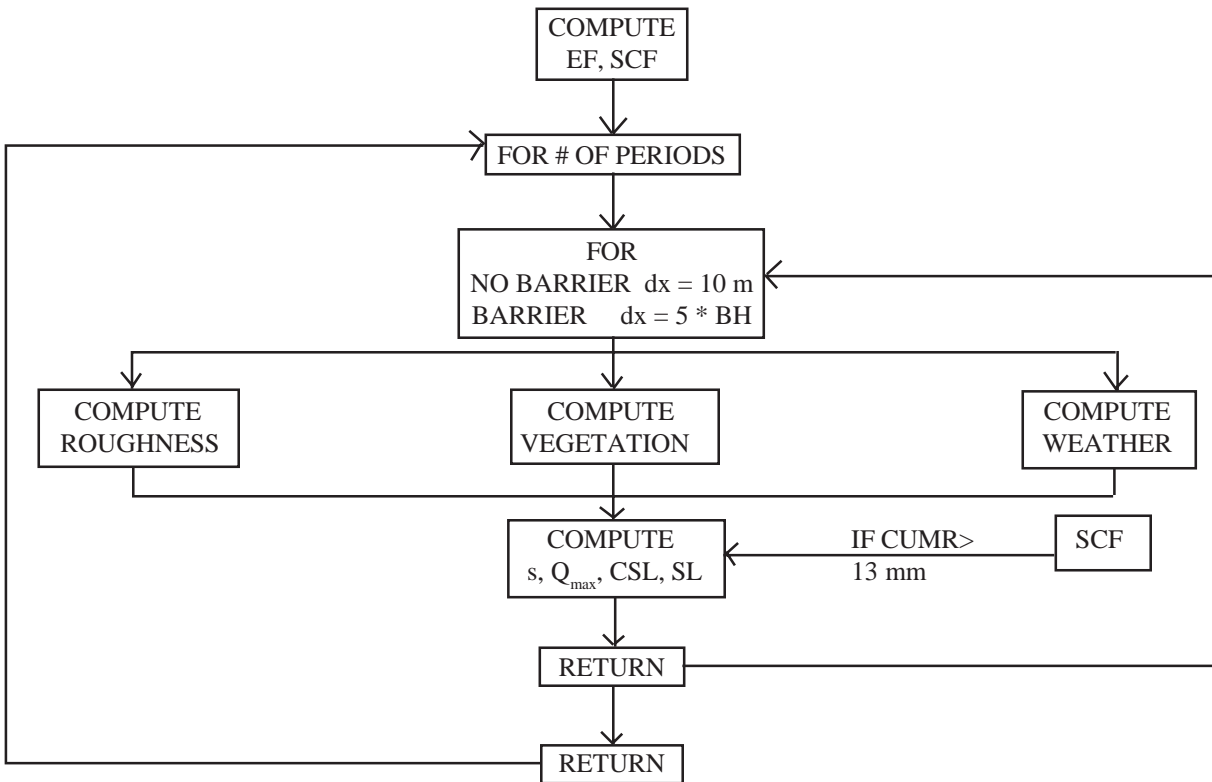|	
YIELD	= crop yield
STEMN	= stem number
RES DEC	= residue decay
pgca	= plant growth coefficient, intercept
pgcb	= plant growth coefficient, slope
T_{max}	= average maximum temperature
T_{min}	= average minimum temperature
PPT	= precipitation
IRR	= amount, rate, and number of irrigations
BC	= burial coefficients
FC	= flattening coefficients
PRC	= % rock and gravel cover
SLR_s	= soil loss ratio for silhouette
SLR_f	= soil loss ratio for flat cover
SLR_c	= soil loss ratio for crop canopy

Flow Diagram 6.1.4
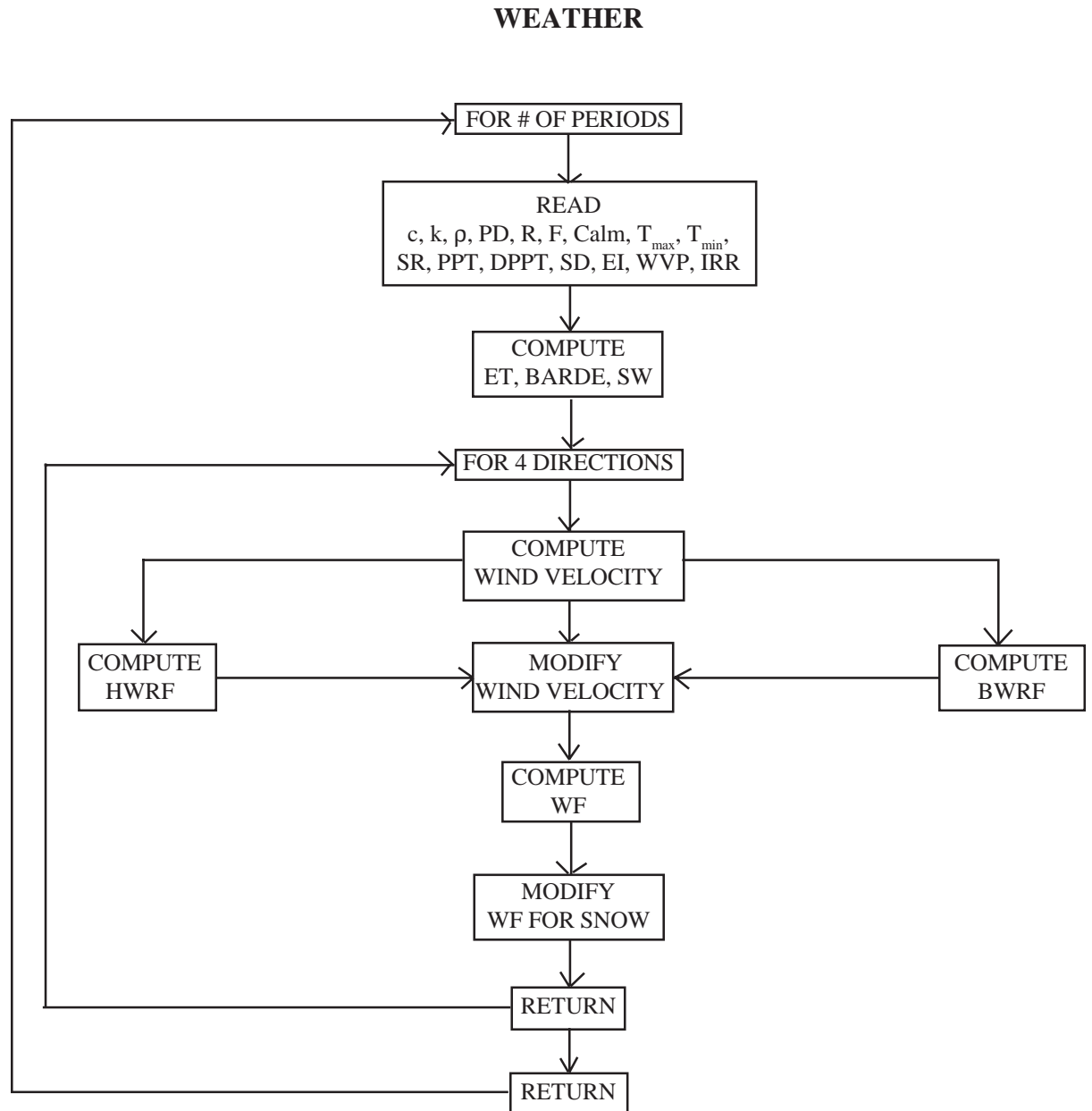
WEATHER

```
                    ┌─────────────────────┐
              ┌────►│  FOR # OF PERIODS    │
              │     └──────────┬──────────┘
              │                ▼
              │     ┌─────────────────────────────┐
              │     │            READ             │
              │     │  c, k, ρ, PD, R, F, Calm, T_max, T_min, │
              │     │  SR, PPT, DPPT, SD, EI, WVP, IRR │
              │     └──────────┬──────────────────┘
              │                ▼
              │     ┌─────────────────────┐
              │     │       COMPUTE       │
              │     │    ET, BARDE, SW    │
              │     └──────────┬──────────┘
              │                ▼
              │     ┌─────────────────────┐
              │  ┌─►│   FOR 4 DIRECTIONS  │
              │  │  └──────────┬──────────┘
              │  │             ▼
              │  │  ┌─────────────────────┐
              │  │  │       COMPUTE       │
              │  │  │    WIND VELOCITY    │
              │  │  └──────────┬──────────┘
              │  │             ▼
┌──────────┐  │  │  ┌────────────┐  ┌──────────┐
│ COMPUTE  │─►│  │  │   MODIFY   │◄─│ COMPUTE  │
│   HWRF   │  │  │  │WIND VELOCITY│  │   BWRF   │
└──────────┘  │  │  └─────┬──────┘  └──────────┘
              │  │        ▼
              │  │  ┌────────────┐
              │  │  │  COMPUTE   │
              │  │  │     WF     │
              │  │  └─────┬──────┘
              │  │        ▼
              │  │  ┌────────────┐
              │  │  │   MODIFY   │
              │  │  │ WF FOR SNOW│
              │  │  └─────┬──────┘
              │  │        ▼
              │  └──┤   RETURN   │
              │     └─────┬──────┘
              │           ▼
              │     ┌────────────┐
              └─────┤   RETURN   │
                    └────────────┘
```

c	= Weibull scale parameter		DPPT	= number of rain days
k	= Weibull shape parameter		SD	= probability of snow cover
ρ	= air density		EI	= storm erosivity index
PD	= prevailing wind direction		WVP	= wind velocity probability value
R	= preponderance		IRR	= amount, rate, and number of irrigations
F	= positive parallel ratio		ET	= evapotranspiration
CALM	= no wind		BARDE	= barrier direction effect
T_{max}	= average maximum temperature		SW	= soil wetness factor
T_{min}	= average minimum temperature		HWRF	= hill wind reduction factor
SR	= solar radiation		BWRF	= barrier wind reduction factor
PPT	= precipitation		WF	= weather factor

Flow Diagram 6.1.5

EROSION

```
                    ┌─────────────┐
                    │  COMPUTE    │
                    │  EF, SCF    │
                    └──────┬──────┘
                           ↓
              ┌──→ ┌─────────────────┐
              │    │ FOR # OF PERIODS │
              │    └────────┬─────────┘
              │             ↓
              │    ┌──────────────────────────┐
              │    │          FOR             │←──────────┐
              │    │ NO BARRIER  dx = 10 m    │           │
              │    │ BARRIER     dx = 5 * BH  │           │
              │    └──────────────────────────┘           │
              │      ↓          ↓          ↓              │
              │  ┌────────┐ ┌──────────┐ ┌─────────┐      │
              │  │COMPUTE │ │ COMPUTE  │ │ COMPUTE │      │
              │  │ROUGHNESS│ │VEGETATION│ │ WEATHER │      │
              │  └────┬───┘ └─────┬────┘ └────┬────┘      │
              │       └──────┐    ↓    ┌──────┘           │
              │          ┌───────────────┐  IF CUMR> ┌─────┐
              │          │   COMPUTE     │←──────────│ SCF │
              │          │ s, Qmax, CSL, SL│  13 mm   └─────┘
              │          └───────┬───────┘
              │                  ↓
              │          ┌──────────┐
              │          │  RETURN  │──────────────────────┘
              │          └─────┬────┘
              │                ↓
              │          ┌──────────┐
              └──────────│  RETURN  │
                         └──────────┘
```

EF	= erodible fraction
SCF	= soil crust factor
dx	= field length simulation spacing
s	= critical field length
Q_{max}	= maximum transport capacity
CSL	= calculated soil loss
SL	= soil loss
CUMR	= cumulated rainfall and irrigation
BH	= barrier height

6.2   GENERAL FLOW DIAGRAMS
The Flow Diagrams 1-9 correspond to the following section numbers.

6.2.1 Overview
A CLIENT file is made up of a WEATHER file and a MANAGEMENT file. When a CLIENT filename is specified in RWEQ, the associated WEATHER and MANAGEMENT files are automatically called into the start program. (Flow Diagram 6.2.1)

6.2.2 Start
The WEATHER and MANAGEMENT files supply data for both RUN and EROSION. (Flow Diagram 6.2.2)

6.2.3 Weather
The operator selects a weather file. The 16 components of the weather file are identified in Section 5.2 and are listed in Flow Diagram 6.2.3.

The computer selects 500 uniformly distributed probability values between 0 and 1 for each time period. These values are used with c, k, and calm coefficients to compute wind speeds at 10 meters. These velocities are converted to an equivalent 2-meter wind speed.   The 2-meter velocities are adjusted for threshold velocity, multiplied by air density, divided by acceleration due to gravity, number of observations, and multiplied by soil wetness and snow cover to compute the weather factor.   The rainfall-temperature-solar radiation data are used to calculate soil wetness.

Weather factors are computed for the prevailing wind direction, perpendicular to the prevailing, and opposite but parallel to the prevailing direction. For each time period, WF 's are computed for four directions. Only the prevailing wind direction WF data are printed in the output file.

The estimated erosion is the soil loss from the downwind edge of the field. Erosion is computed for four wind directions. For each time period there are four erosion estimates, four critical soil loss values, and four critical field lengths. Erosion output is the total soil loss from the four directions.

Temperature and rainfall/irrigation data are used in RUN to decay plant residues.   Rainfall/ irrigation amounts, rain/irrigation days, and EI values are used in RUN to adjust soil roughness.

6.2.4 Management
The MANAGEMENT input file contains information on CROP, TILLAGE, SOIL, irrigation, period, field, hills, and barrier that is unique to a single field or farmer. A management file contains input for RUN and EROSION. (Flow Diagram 6.2.4)

6.2.5 Soil
The SOIL file contains input data on percent sand, silt, organic matter, calcium carbonate, and rock cover. These data are used to compute the erodible fraction (EF). The EF is considered a property of the soil and is not adjusted within RWEQ. (Flow Diagram 6.2.5)

6.2.6 **Crop**
The CROP file contains input on residue decomposition and crop canopy coefficients. The operator must input crop yield and an estimate of the number of standing stems in a unit area. The operator may also input percent ground cover on any operation date. (Flow Diagram 6.2.6)

6.2.7 **Tillage**
The TILLAGE file contains input for ridge height/spacing, random roughness, ridge orientation, and residue burial and flattening coefficients. The operator may overwrite any of these values in the **DOABLE SCREEN** to customize the implement effects for a specific region or farmer. (Flow Diagram 6.2.7)

6.2.8 **Run**
Within RUN soil roughness/residue level data are generated for each time period. This is the only loop in RWEQ where values are updated as the erosion season progresses. (Flow Diagram 6.2.9)

In RWEQ RUN assembles input from SOIL, TILLAGE, and CROP. Initial values of soil roughness and residue levels are modified with input from MANAGEMENT and WEATHER. The modified values for surface roughness and residue levels at the end of a time period are initial conditions for the next period.

SOIL, TILLAGE, and WEATHER data are used to compute soil roughness decay. The rock cover from SOIL is added to the flat cover value in CROP to provide a single SLR_f coefficient. Rock cover is not changed with tillage or weather.

SCF is automatically set to a value of 1 by any tillage operation that disturbs the soil surface. When 13 mm of precipitation is received after a tillage operation, the SCF is used in EROSION.

Changes in standing residue mass are computed using weather file and crop decomposition. The plant growth coefficients are used to compute canopy cover based on days after planting.

Flat and standing residue mass decay rates are a function of crop, number of rainfall/irrigation events, and temperatures within the time period. The mass values at the end of each time period are adjusted with burial and flattening coefficients from TILLAGE. The remaining mass is converted to Soil Loss Ratio coefficients for flat cover (SLR_f), for standing silhouette (SLR_s), and if there is growing vegetation, for crop cover (SLR_c).

From the ridge height/spacing input data a ridge roughness coefficient (K_r) is determined. When K_r is combined with random roughness, soil roughness perpendicular (K') to the wind is computed. Random roughness is decayed with rainfall/irrigation amounts (*CUMR*) and *EI* values (*CUMEI*) for each period.

6.2.9 **Erosion**

Estimates of erosion are based on the *WF* adjusted for barriers, hills, ridge orientation, and surface conditions for a 1 to 15-day period. No adjustments in *EF*, *K'*, *K"*, or residue levels are made within a single time period or during an erosion event.
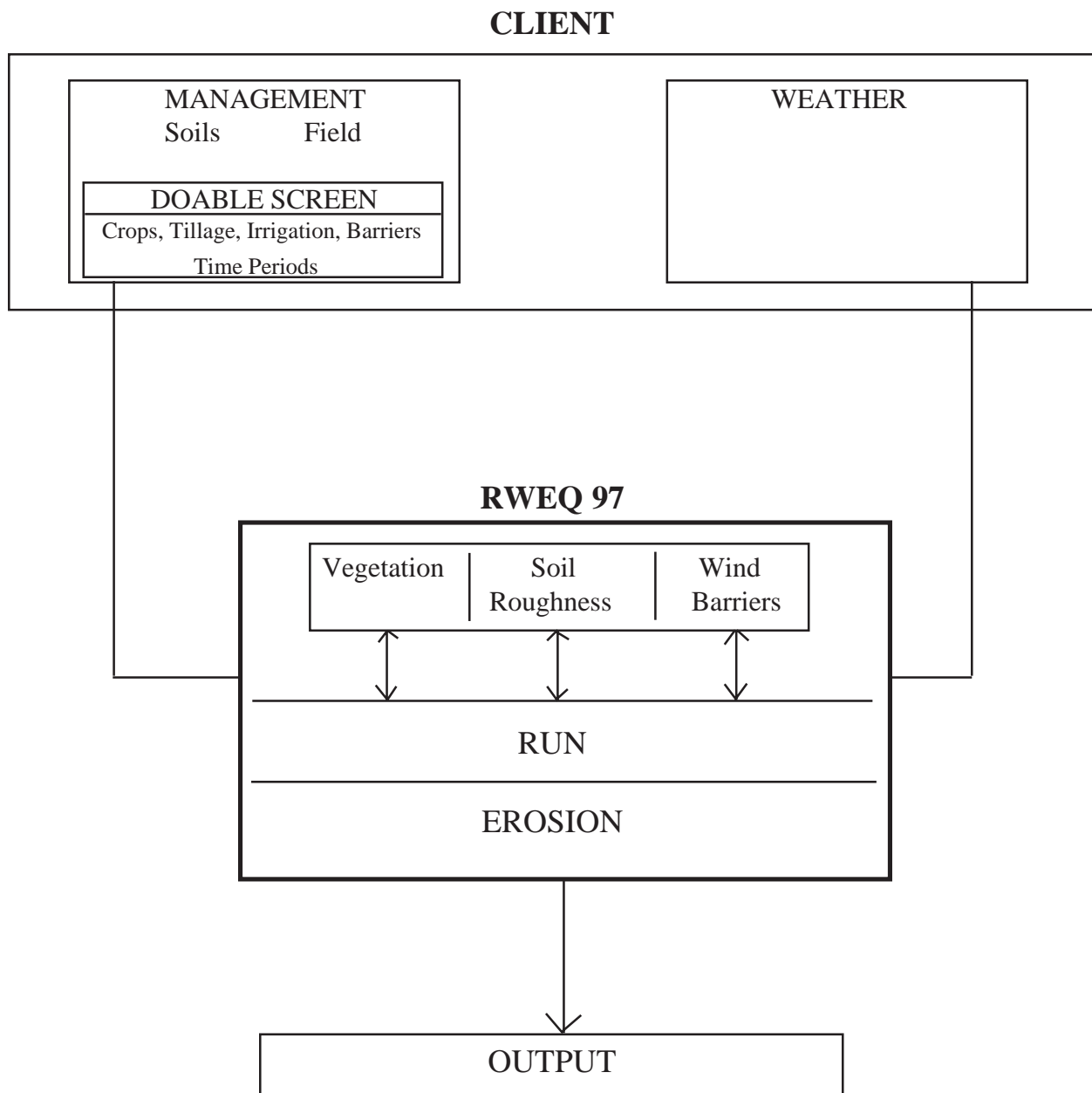
RWEQ computes the average field length for 200 equal width strips. The average of the 200 field lengths is used to compute the mass loss. Total mass is divided by the field area to compute average soil loss (*SL*). EROSION computes the field length (*s*) where the wind has attained 63.2% of the maximum transport capacity. EROSION also computes the maximum transport capacity of that wind over that field surface. Output from EROSION does not loop to any other routine within RWEQ.

6.2.9.1 **Barriers:** Annual or perennial barriers reduce the leeward wind speed. The protected zone of a barrier is influenced by wind speed and barrier properties.
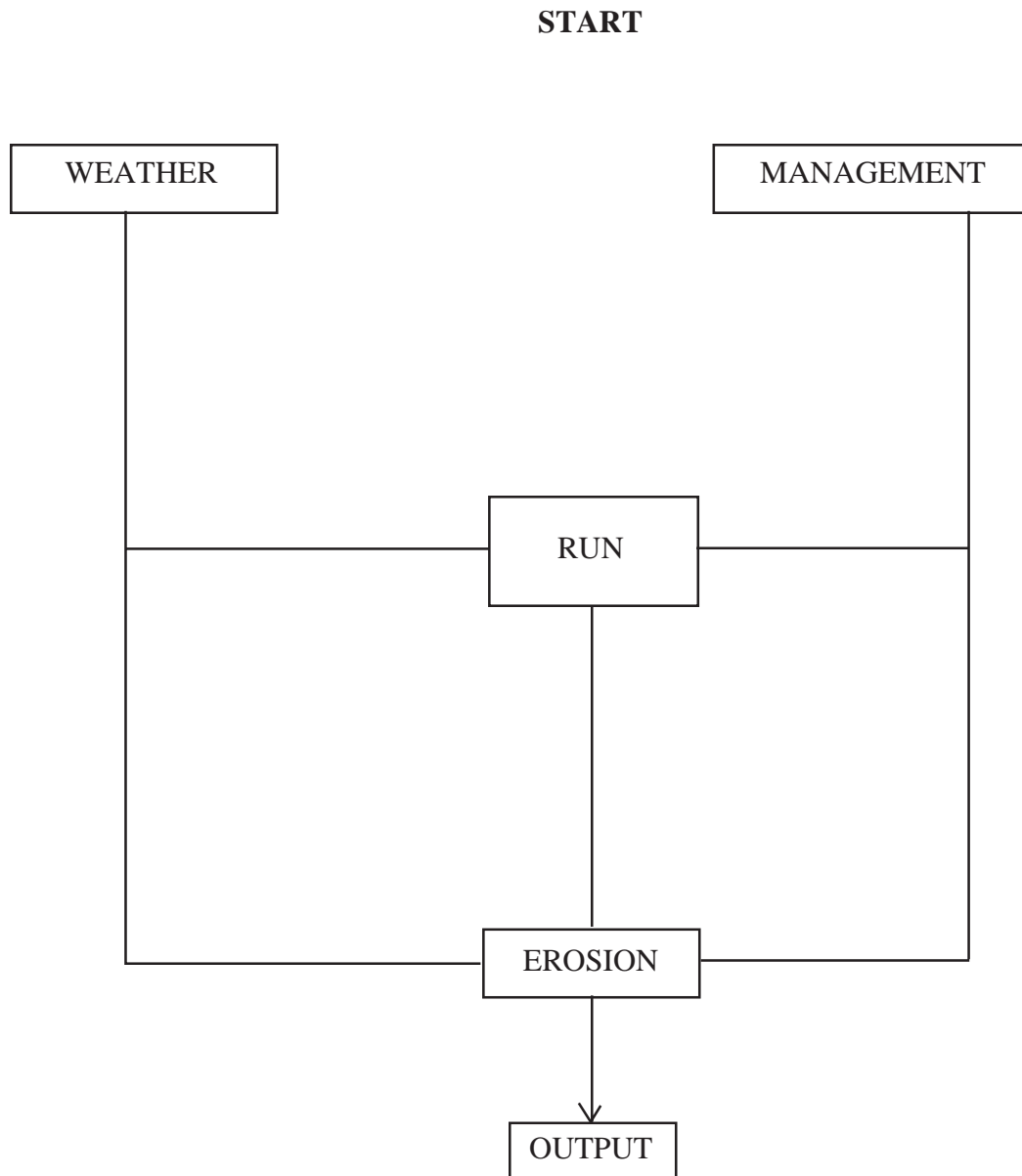
Distance increments for are 10 meters for a no-barrier field and 5 barrier heights (BH) for a field with windbarriers.

6.2.9.2 **Hills:** Hills or knolls increase the velocity of the wind on the upwind slope and decrease the velocity on the downwind slope. A hill may be treated as a separate field to modify soil erodibility or residue levels.

Flow Diagram 6.2.1

CLIENT

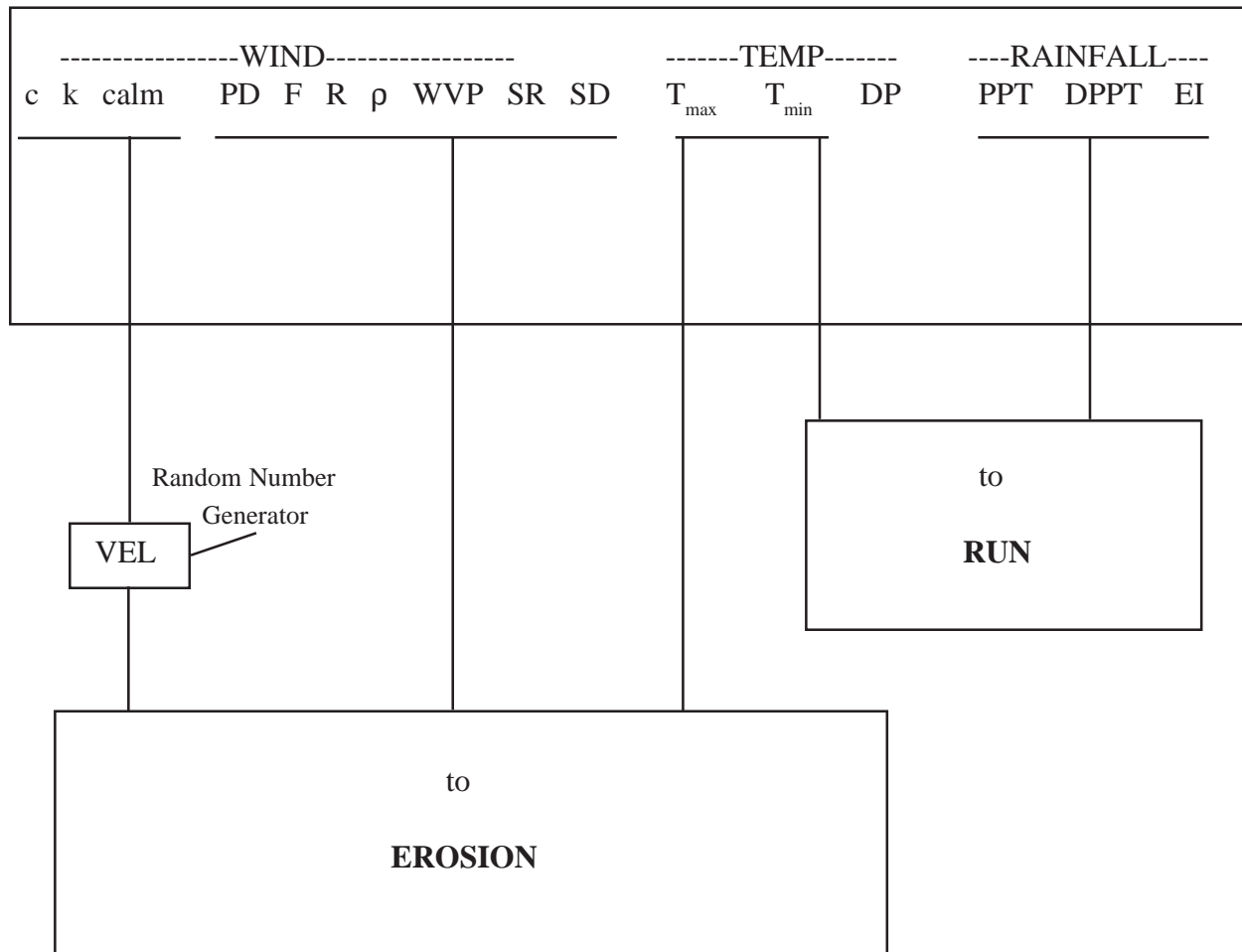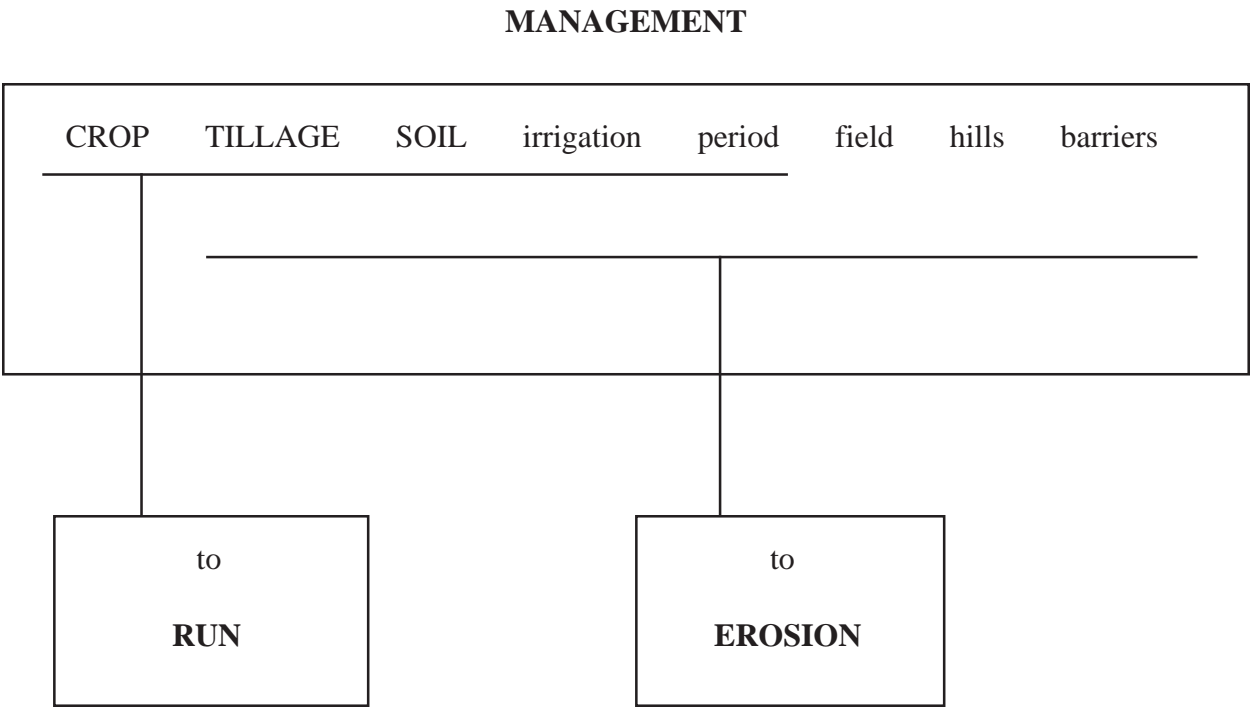| MANAGEMENT	WEATHER
Soils Field	
DOABLE SCREEN	
Crops, Tillage, Irrigation, Barriers	
Time Periods	

RWEQ 97

Vegetation	Soil Roughness	Wind Barriers

RUN

EROSION

OUTPUT

Flow Diagram 6.2.2

START

```
┌─────────────┐                          ┌──────────────────┐
│   WEATHER   │                          │    MANAGEMENT    │
└──────┬──────┘                          └─────────┬────────┘
       │                                           │
       │              ┌─────────┐                  │
       ├──────────────┤   RUN   ├──────────────────┤
       │              └────┬────┘                  │
       │                   │                       │
       │              ┌────┴─────┐                 │
       └──────────────┤ EROSION  ├─────────────────┘
                      └────┬─────┘
                           │
                           ▼
                      ┌─────────┐
                      │ OUTPUT  │
                      └─────────┘
```

Flow Diagram 6.2.3

WEATHER

-----------------WIND------------------ -------TEMP------- ----RAINFALL----

c k calm PD F R ρ WVP SR SD T_{max} T_{min} DP PPT DPPT EI

Random Number
Generator

VEL

to
RUN

to

EROSION

c	=	Weibull scale parameter
k	=	Weibull shape parameter
calm	=	percent of calm time
PD	=	prevailing wind erosion direction
F	=	positive parallel ratio in opposite directions
R	=	preponderance in PD
ρ	=	air density
WVP	=	wind velocity probability value
SR	=	solar radiation

SD	=	probability of snow depth greater than 25.4 mm
T_{max}	=	average maximum air temperature
T_{min}	=	average minimum air temperature
DP	=	dew point temperature
PPT	=	precipitation
DPPT	=	number of rain days
EI	=	erosiveness index from RUSLE databases
VEL	=	wind velocity

Flow Diagram 6.2.4

MANAGEMENT

CROP   TILLAGE   SOIL   irrigation   period   field   hills   barriers

to

RUN

to

EROSION

Flow Diagram 6.2.5

SOIL

sand   silt $CaCO_3$ organic   rock
matter   cover
OM   PRC

clay

clay	erodible	OM PRC
to	fraction	
	EF	
RUN	to	to
	EROSION	**RUN**

Flow Diagram 6.2.6

CROP

residue crop	yield	stem number	growing crop
CORE values: crop input data (Appendix B-1)			plant canopy coefficients (Appendix B-2)

to

RUN
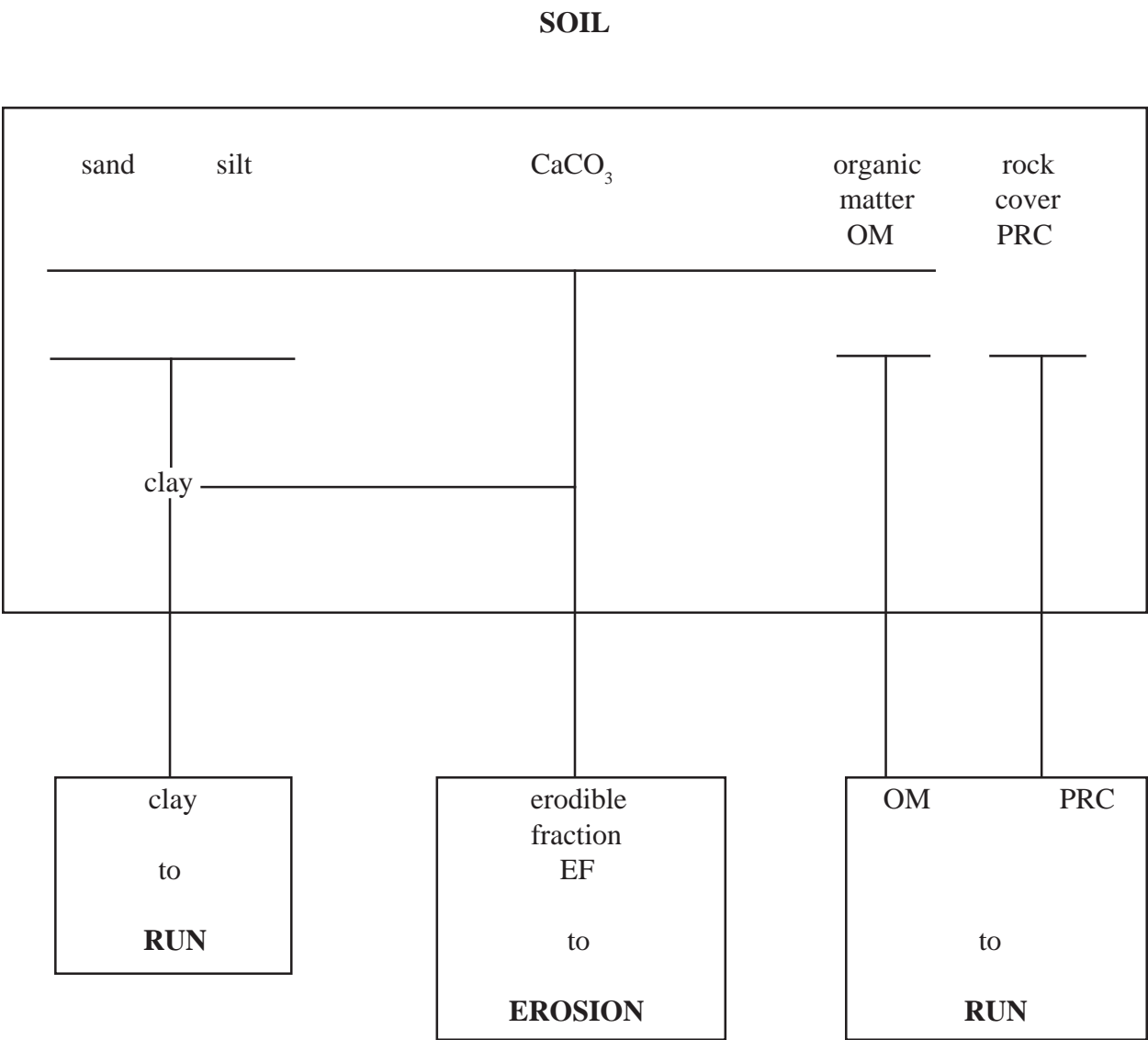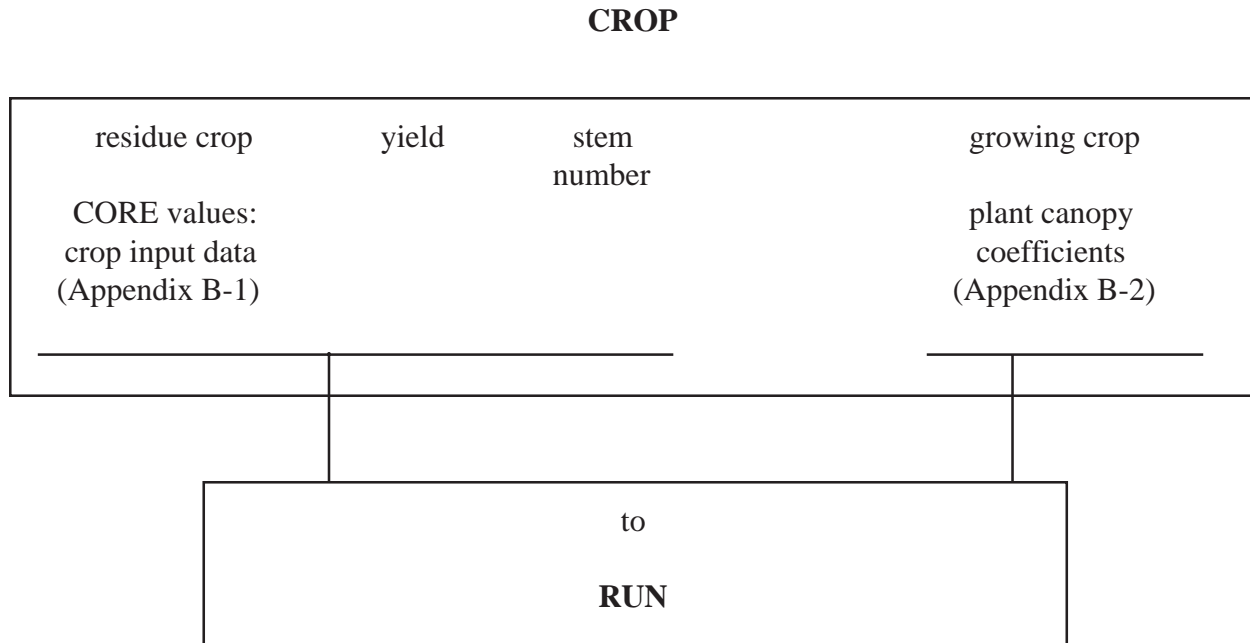
Appendix B-1: CORE Values: Crop Input Data Set

y_a	=	yield intercept
y_b	=	yield slope
CH	=	crop height
SDIAM	=	stem diameter
HH	=	after harvest height
k_{ms}	=	standing mass loss coefficient
k_{mf}	=	flat mass loss coefficient
k_{sn}	=	stem decline coefficient
mcf	=	mass/cover conversion coefficient
tof	=	takeoff factor
dd_o	=	stem number threshold decomposition days

Appendix B-2: Plant Canopy Coefficients for Growing Crops

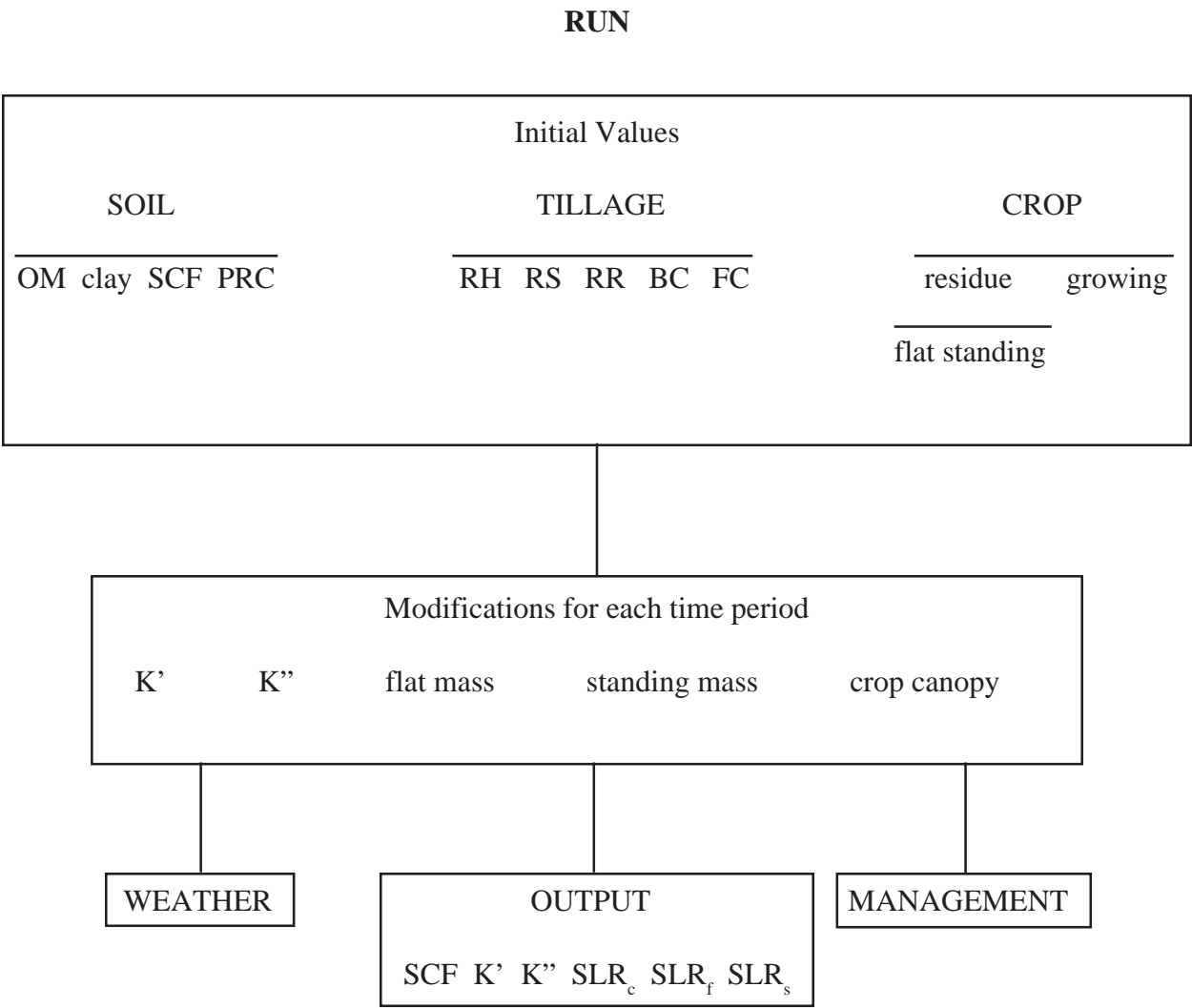|		
pgca	=	plant growth coefficient
pgcb	=	plant growth coefficient

Flow Diagram 6.2.7

TILLAGE

ridge height	ridge spacing	random roughness	residue burial coefficient	residue flattening coefficient	ridge orientation
RH	RS	RR	BC	FC	RO

to

RUN

to

EROSION

Flow Diagram 6.2.8

RUN

Initial Values

SOIL

OM clay SCF PRC

TILLAGE

RH RS RR BC FC

CROP

residue   growing

flat standing

Modifications for each time period

K'   K"   flat mass   standing mass   crop canopy

WEATHER

OUTPUT

SCF K' K" SLR_c SLR_f SLR_s

MANAGEMENT

Flow Diagram 6.2.9

EROSION

WEATHER		MANAGEMENT

Input from RUN

SCF   K'   K"   SLR$_c$ SLR$_f$ SLR$_s$

EROSION calculations

OUTPUT

K'   K"   SLR$_c$ SLR$_f$ SLR$_s$ V   WF   WD   E   CSL   Q$_{max}$ s   SL

K'	=	soil roughness perpendicular to prevailing wind
K"	=	soil roughness parallel to prevailing wind
SLR$_f$	=	flat residue cover plus rock cover coefficient
SLR$_s$	=	silhouette coefficient
SLR$_c$	=	growing crop canopy coefficient
V	=	vegetation (SLR$_f$ x SLR$_s$ x SLR$_c$)
WF	=	weather factor

WD	=	prevailing wind direction
E	=	erosion
CSL	=	critical soil loss
Q$_{max}$	=	maximum transport capacity
s	=	critical field length
SL	=	average field soil loss